The Transit Method

Discovering Exoplanets

Classroom Activity

Overview

Age Range:

11-13 years old

Prep. Time:

15 minutes

Lesson Time:

1 hour 45 minutes

Cost per activity:

Low

Includes the use of:

Laptop with webcam and light grapher software

Outline

Students will first learn about ExoPlanets and the difficulty scientists have detecting them.

In this activity students use a lamp and polystyrene balls to model how astronomers detect exoplanets using the transit method.

Using a piece of software to aid them, students will complete an experiment to plot light curve graphs created by objects passing in front of a light source.

Pupils will Learn:

- Understand that the transit of a planet in front of its star temporarily reduces the star's measured brightness.
- Understand that a light-curve is a graph of "brightness" against time.
- Describe and explain how different factors (including size of exoplanet and orbital speed) affect the light-curve observed during a transit.

Lesson Plan:

Overview of the time required to complete lesson.

The online observatory collaboration consists of the following partners:
Baldone Observatory, Brorfelde Observatory, Cardiff University, Harestua Solar Observatory, Helsinki Observatory

Description	Time	Notes
Introduction to the subject	15 min	Use: https://www.cfa.harvard.edu/~avanderb/tutorial/HAT-P-3b.gif https://www.youtube.com/watch?v=BFi4HBUdWkk
Activity 1	30 min	Download the Light Grapher software: http://www.planetarium-activities.org/shows/sp/lightgrapher (you may also need to download a flash player for windows https://www.globfx.com/downloads/swfplayer/ or Mac https://echoone.com/iswiff/)
Assessment	15 min	Predict the light-curves that will be produced by different planets Use activity sheet 1 from: https://www.iop.org/education/teacher/resources/exoplanet_physics/file_65609.pdf
Break	15 min	
Activity 2	30 min	Test predictions using different size and speed balls, taking into consideration what other factors must remain constant

Introduction to the subject:

Introduce the idea of an exoplanet and explain why they are difficult to observe. (They are very distant and much smaller than stars, and they are not sources of light.) Explain that a number of techniques have been developed to observe exoplanets so that we now know of thousands. Explain that they are going to model the transit method in which the brightness of a star is measured as the exoplanet orbits it.

Activity 1:

- Practise using the Light Grapher software and explain to students how it works
- Divide students into groups of 2 to 4

Steps of activity:

1. Students should **set up a lamp to represent their star** and **attach a ball to a skewer** to represent their exoplanet.

2. Then **move their ball** on skewer/stick across the front of their lamp and **produce a light-curve**, using the light grapher software
3. Once students have produced a single light-curve, they should **predict how the shape of the light curve will change for a bigger and faster exoplanet**.
4. Have the **students test their predictions**, encouraging them to think about which variables they need to keep constant (e.g. radius of orbit)

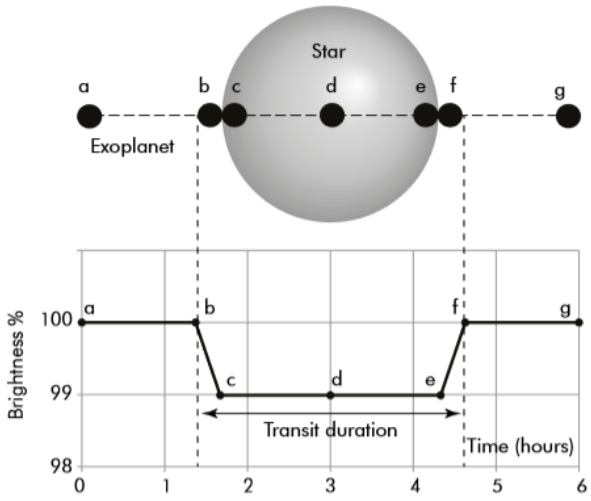
Further Activities:

The transit method is just one technique that astronomers use to search for exoplanets. Use the internet to find other ways of detecting exoplanets.

Background Knowledge:

About light-curves

The brightness is shown as a percentage, with the percentage of brightness on the y-axis and the time on the x-axis. An idealised light curve for a Jupiter-like planet crossing the disc of a Sun-like star is shown in the figure below.



A faster exoplanet moves across the face of the star more quickly and so the dip in intensity lasts for a shorter time. A larger exoplanet obscures more of the star's surface during a full eclipse and so the dip in intensity is larger.

Based on IOP activity: https://www.iop.org/education/teacher/resources/exoplanet_physics/file_65609.pdf